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ABSTRACT

This paper reports on a study of general biology students (N=24) in a small college environment in the Columbus, Ohio area. Comparisons are made between student learning styles, perceptual modalities, and their responses on Likert and open response survey items. Student perceptual modalities are also correlated with the students' choices of final projects and their achievement on classroom assessments. Four themes are identified from the data analysis: (1) students who prefer experiential learning in this study are identified as using the kinesthetic and perceptual modalities; (2) student achievement increases with choice; (3) field experiences can enhance and become more motivational to non-science majors and non-traditional students; and (4) the use of a variety of teaching techniques is beneficial to college science teaching. (Contains 12 references.) (DDR)

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Using Field Experiences to Enhance College Science

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The nature of classroom science is slowly becoming transformed into a process-driven, inquiry-based domain. Educators are encouraged to link class work to students' personal and social considerations. Educators are asked to collaborate in the creation of a nation of scientifically literate members. This new direction is prescribed by *Project 2061: Science for All Americans* and supported by publications such as *Benchmarks for Science Literacy*, the *National Science Education Standards*, and *Educating Americans for the 21st Century*.

The National Science Board Commission on Pre-college Education in Mathematics, Science and Technology (1983) stated the following:

> Much that affects the quality of the formal education occurs outside the classroom and beyond the control of the school-a great deal of learning takes place unintentionally and unconsciously through casual reading and experiences. The process has been referred to as informal or experiential learning and offers an important opportunity for improvement in our overall educational system. Such opportunities are particularly helpful for the sciences and technology...

Formal education must be supplemented by a wide range of activities that can reinforce the lessons of the classroom and lend meaning and relevance to the rigor and discipline of the formal study (*Educating Americans for the 21st Century*, 1983, p.59).

Project 2061, Science for All Americans, is intended to help formulate the shared national vision on what understandings and habits of the mind are necessary for developing a scientifically literate society. This unfolds into a three way plan that includes establishing the substance of scientific literacy, transforming curriculum, and encouraging wide spread collaboration to that end. Embedded in the Project is the notion that " schools do not need to be asked to teach more and more content, but rather to focus on what is essential to scientific literacy and to teach it more effectively (p.4)." It suggests that the topics be covered in two nontraditional ways. First, that the boundaries

between disciplines soften and connections are emphasized. Second, the amount of detail is reduced and ideas and thinking skills are encouraged. They suggest several conditions essential to make this occur. Briefly, they include the following. Curricula must be changed to reduce the amount of material covered; scientific ways of thinking are encouraged. Teaching should be consistent with the spirit and character of scientific inquiry and values. Educational reform should be comprehensive and focus on the needs of all learners. Reform must be collaborative.

Willingness to enact these considerations is necessary to meet this national goal. The college science teacher is faced with the challenge of providing a curriculum to college science non-science majors to fulfill interdisciplinary curriculum requirements. Often these students have preconceived notions about science that make it seem too complex or difficult to understand, too boring or irrelevant. The function of the science instructor therefore includes stimulating interest of these students and the demonstration that science is not isolated but a meaningful subject to their daily lives. A study by Labianca (1975), examines the popular considerations students employ for selecting science courses. The first consideration was recommended by a friend (30%), second, "fit into their schedule" (20%), third, "most pertinent to student's interest" (14%), and fourth, perception to be the easiest science course (14%)(p.189).

It has been difficult to break away from the "brightest and the best" policies the Sputnik years that served only the science majors. Campus communities are now trying to determine how to best meet the needs of students with different backgrounds, career aspirations and learning styles. These challenges lead to the current generation of reforms. These reforms have taken the form of "Hands-on" or discovery-based, learning communities and learner-centered education, the integration of research and education,

learning that is contextual/constructivist, programs, that are lean and lab-rich. In fact, a primary movement for more than a decade has been the focus on undergraduate research, by which faculty translate phrases about "hands-on" and "lab rich" into action. (Narum, p.9)

Most of these words are clichés in science education but they reflect the role of action in science education, a strategy designed to attract and sustain student interest in thinking and doing science. Changes illustrate that institutions are revisiting traditional teaching of science where the learner was the passive receiver of information to a shifting paradigm of student-active construction that is dependent on contextual acquisition and application of knowledge.

The issue of the science laboratory component is also under scrutiny as a methodology that promotes learning. On the topic of science laboratory experiences, Hegarty (1982) states:

> Research on the current status of laboratory class work in colleges and schools suggests that the potential is seldom being fulfilled. Where the classes could be filled with the spirit of scientific inquiry, they are dominated by procedures of low scientific status and talk that often fails to lead to meaningful learning. Laboratory experiences are considered in isolation; students' background conceptions are not brought to bear, and their misconceptions are not confronted. Opportunities are missed for providing memorable events to aid students in their acquisition of knowledge and concepts (p.104).

The notion of experiential learning is often considered a new, even reformation concept but "learning by doing" has been acknowledged since the time of the Greek Philosopher, Socrates. Socrates believed that student's had something to contribute to learning and that process of becoming educated was the important thing, rather than arriving at a final static state. John Dewey (1938) noted that learning does not begin with some metaphysical attraction but with experience of the real world.

The Public Linkage, Dialogue, and Educational Task Force of the President's Council on Sustainable Development (1997) wishes to develop educational strategies to reach people of all ages and at all phases of life. One suggestion they offer is that that education for sustainability can be accomplished by emphasizing "relationships between formal and nonformal education (p.17)." Nonformal venues such as museums, zoos, and the like were cited as environments that provide lifelong learning opportunities. It was noted that these organizations should work closely with educators to identify areas in which schools have not prepared students adequately. Once identified, nonformal educators can develop materials and work with educators. Several sources of nonformal education listed as deserving special attention included: broadcast media, work-based learning, and community outreach and participation. Koran and Shafer (1982) state that the potential magnitude of science learning in these settings far exceeds that which occurs in the formal classroom setting!

There are a wide variety of characteristics that distinguish an informal learning experience from a formal one, learners in informal settings experience no classroom structures, no time constraints, no coercive forces, and no grades. They are in an exploratory context, able to move around at their own pace and attend those settings that attract them. Usually the differences among the learners and the differences in the amounts or kinds of things to be learned provide "something for everyone" (pp.52-53). They conclude:

> Informal learning in science is a potentially valuable adjunct to school instruction ... however if we become too involved we can transform an informal experience into a formal school experience with at least some negative connotations. With thought and care, this part of the learning environment could become significant for the science education of youth...(p.62)

The Research on Learning Styles and the Dunn Model

Interest and the study of learning styles (LS) has developed over the last 30 years. One LS theory, Dunn and Dunn (1978) is the most comprehensive in scope and practice for teachers. (DeBello, 1990) Learning styles are unique ways individuals perceive and process new or difficult information according to Dunn and Dunn (1978).

The Dunn Model:

The inventory of learning styles created by Dunn, Dunn & Price (1979, 1980, 1990) is composed of five major categories called stimuli that may influence learning. Within each are individual elements. The five major stimuli of the model are very specific:

- **Environmental:** includes: light, sound, temperature, room design;
- **Emotional:** includes: structured planning, persistence, motivation, responsibility;
- **Sociological:** includes: pairs, peers, adults, self, group, varied;
- **Physical:** includes: perceptual strengths, mobility, intake, time of day; and
- **Psychological**: includes: global/analytic, impulsive/ reflective, right- and left-brain dominance.

Within these five major categories are 21 different individual elements that influence our learning. As one develops and accumulates experiences, one comes to rely ón some of the elements more than others. For most individuals, four or five of the elements become extremely important when attempting to learn new or difficult information. Giving attention to the elements that most influence a person's learning is what constitutes one's individual learning style.

Background and Need for Study

This study was conducted in the fall of 1997 at a small private college in the Columbus, Ohio area. The students were enrolled in a general biology course, which they had selected as part of their science requirement for their baccalaureate degree. The students were non-science majors, and of non-traditional college age. Their ages ranged from 22 to 49 years. The gender distribution was 5 males and 19 females. The total class size was 27 students and the sample size was 24. Three students did not complete all portions of the surveys and instruments.

Procedure

The procedure included both qualitative and quantitative methods. Qualitative methods included student demographic surveys and student field survey that included two components: a Likert scale portion and an open-ended response portion. The quantitative portion included the Dunn, Dunn, & Price Learning Style Inventory (LSI), (specifically the Productivity Environmental Preference Survey) and student assessments including: lab, quiz, test, and final project grades.

Comparisons were made between student learning styles, specifically their perceptual modalities, and their responses on the Likert and open response survey items. Student perceptual modalities were also correlated with their choice of final projects and their achievement on classroom assessments.

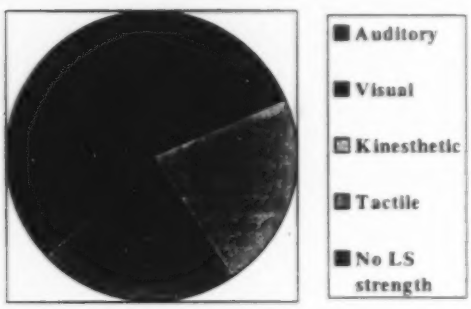
Qualitative results compared student learning style with preferences expressed on the surveys. Emergent themes and patterns were noted in their relation to lab and field experiences and preferences toward learning in science.

Data & Analysis

The distribution of LS perceptual strengths of this class indicated that only three students were auditory learners, two were visual learners, six had kinesthetic strengths, and six had tactual strengths, and ten had no perceptual strength as indicated on the Dunn, Dunn & Price LS instrument. Four students had two perceptual strengths and were included in both of the modality categories of their strengths.

The following graphic shows the distribution for this class

Learning Styles (Perceptual Strengths) of Students



- N = 24
- Includes 4 Students with Two LS Strengths

Comparisons of mean averages and perceptual strengths indicated that kinesthetic learners did exceptionally well on lab activities. They also did extremely well on quizzes and tests. Students without perceptual strengths performed well on the final projects but not as well on quizzes, labs, and tests. Tactile individuals did well at final projects.

The student's choice of final projects was closely connected to student perceptual strengths, as indicated in the chart that follows. Visual and auditory students were not well represented in this class, and thus were excluded from some of the analysis.

Correlation of Choice of Final Projects with LS Strengths

- **Auditory** LS: All chose to complete traditional final projects
- **Tactile** LS: All chose to complete at least one field or lab activity
- **Kinesthetic** LS: Two-Thirds chose at least one field or lab activity
- **No LS Preference**: Nine-Tenths chose at least one traditional project

Field surveys were completed following a class field experience to the research and endangered animal park called "The Wilds." Following the guided tour and questions, students completed a survey covering their perceptions, experiences, and learning styles. Kinesthetic students rated the field experience as most valuable compared with tactile and students without perceptual strengths. There was not enough data on students with auditory or visual perceptual strengths to judge their perceptions of the use of field experiences. Perceptions of students were collected from their responses on Likert items and free response questions.

Achievement on various components of the biology course and the final grades were compared considering student learning styles. Students were expected to complete two final projects in lieu of a final exam. Projects ranged from traditional (written reports, annotated bibliographies, book reviews, summaries of biology articles) to non-traditional forms (labs, field experience reports, movie and video reviews, etc.). In

general, students who completed projects consistent with their perceptual strength achieved either an A or B on the final projects. Students without perceptual strengths as indicated on the Dunn, Dunn & Price LSI, generally opted to complete traditional projects. LS strengths did not indicate final grade averages in this course.

Student responses reporting how they learn best revealed some interesting comments, as the following chart indicates. Many of these adult students are aware of their personal learning strengths, preferences, and needs. This data was gathered from the open-ended questions on the field survey.

Responses to: How do you best learn science?

- "Hands on: doing, feeling, touching."
- "I also tend to remember things that are presented in a less traditional manner (such as stories, personal experiences, or things that are little known or quirky."
- "I am a hands on practical application learner. I can learn more from a picture than from the proverbial '1000 words.'"
- "Visual with auditory comments."

Students also indicated the impact of field experiences on their learning. Responding to open-ended questions, students revealed many insights. A sample of their comments follows. Again, this indicates that many students in this class were aware of the benefits of participation in engaging informal science experiences.

Responses to: What is the impact of this field experience upon your learning of science?

- "Balance of power is very important. I learned how closely everything is connected."
- "It sparked my interest in evolution, particularly what in the evolutionary process causes extinction."
- "...shows how biology affects every aspect of our lives. The things we do for entertainment can all be linked with biology."
- "It tweaked my curiosity."

Emergent Themes and Patterns

In this study, and for this particular population, four themes emerged. Student preference for experiential learning correlated with their LSI scores. In other words, students who preferred experiential learning were generally of the kinesthetic and tactile perceptual modalities. This is what one would expect. However, it was peculiar that the majority of the students in this class were of either of these these modalities, because as Dunn (1996, 1997) reported, the two most prevalent modalities among adults are visual and kinesthetic. Also, it was unique that this population had a large number, ten, who did not have a perceptual strength according to the Dunn, Dunn & Price LSI.

A second theme was the finding that student achievement increased with choice. Students who completed final projects consistent with their perceptual modality, achieved grades on those projects in the A or B range. This was especially true for students with kinesthetic perceptual modalities who consistently achieved high marks if they completed final projects consistent with their perceptual strength. As an example, students who completed a field report as one of their final projects, usually did an exceptional job on that report, and achieved an A or B average on that project. Whereas, students who were tactual and completed a project that was more consistent with a visual or kinesthetic modality did not usually achieve a high average. This was also born out by comparing remarks made from surveys regarding how individual students perceived the process of science and the completion of field projects. Kinesthetic students strongly agreed that field experiences were important to learning science.

Student achievement for the class as a whole increased with the increased choice of assignments, especially choice on the final projects. Student grades before completing

the final projects were averaging lower than those calculated with the final projects. The choice of final projects allowed many students the chance to select projects within their perceptual modality. The mere choice of different perceptual projects does not assure an increase in achievement.

Field experiences can enhance and become more motivational to non-science majors and non-traditional students. This was evidenced in student written responses on the field survey and from the assessment of their final projects. Many students appreciated and commented favorably on the choice of final project options on the final course evaluations.

The use of a variety of teaching techniques is beneficial to college science teaching. This correlates to the variety of learning styles or student perceptual strengths as evidenced in data collected from this population. College students are not a homogenous group and do not react equally well to assignments that are congruent with one or two perceptual modalities.

Discussion

Several areas of this research study need further exploration. For example, the findings for this study were with non-traditional. science students, would these findings be similar to those of other content areas or of other more traditional students, or of science majors? What would occur in populations with a greater representation of auditory and visual students? The choices and achievement may change with the changing populations and changing perceptual modalities.

Another area that needs some research is that of how other elements of the Dunn LS model would impact achievement and perception of science. Two other elements that may be revealing could be motivation and structure. The Dunn model is more

comprehensive than the modalities and could be used further to explore correlations between student perceptions of science and their performance in science college courses.

Several colleges involved in curriculum transformation toward student-active science include:

Elmira College, Elmira NY

California State College Fullerton, Fullerton CA: Biology 101 " In what ways does chemistry (or biology) impact my personal life and society?"

Saint Joseph College, Hartford CT: Science and Technology-Historical and Cultural Contexts (included "mini papers on personal topics of interest, group projects, and a personal research project.)

Portland State University, Portland OR: A three tiered science curriculum including Natural Science Inquiry, Integrated Science Concepts, and Context of Science in Society.

Spelman College, Atlanta GA: Interdisciplinary Science The Evergreen State College, Olympia WA: Science and Society.

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